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A STUDY OF THE EFFECT OF LEAN SIX SIGMA'S CRITICAL SUCCESS FACTORS IN INDIAN SMEs

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ABSTRACT

Small and Medium Enterprises (SME) are becoming an important part of the global economy by providing huge employment opportunity and stable support to GDP growth to many of the countries. SMEs face difficulty to compete in the market with large companies and various competitors. The SMEs need to be in the market with adequate product quality with minimal price than the competitors. This makes the SMEs concentrate on quality management models. Lean Six Sigma (LSS) is a proven quality management approach that can enhance the performance of industries. The industries can improve quality by reducing the costs and variations and thus increase the profit through LSS implementation. This study is aimed at the identification of Critical Success Factors (CSF) of Indian SMEs towards LSS implementation. The study identified 9 CSFs which support the industries in implementing LSS. The study also compared the effect of these factors in industries with various classifications. This study is the initial part of the author's research work which led to the development of a tailor-made model termed Identify-Rank-Define-Analyse-Improve-Control (IRDAIC) model and validation of the model by implementing it in SMEs.

KEYWORDS: Critical success factors (CSF), Lean six sigma (LSS), Identify-Rank-Define-Analyse-Improve-Control (IRDAIC), Small and Medium Enterprises (SMEs)

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INTRODUCTION

The Small and Medium sector enterprises (SME) are the important pillars of the global economy. SMEs act as a backbone of many of the country's economic growth and provide a huge employment opportunity (Chiware and Dick, 2008, Singh et al., 2008). The literature interchangeably uses terms SME and Micro, Small and Medium Enterprises (MSME). This research uses the term SME, as the working of Micro firms does not have homogeneity and hence excluded from the study. In India the term MSME evolved in 2006 by the MSME Development act of Ministry of MSME, Government of India. Before that, the classification was Small Scale Industries (SSI) and Non-SSIs (Ministry of MSME, 2006). Various countries classified the MSME based on different criteria such as initial investment; number of employees working; company turnover; and company balance sheet. In India, the classification is purely based on the initial investment, which is as given in table 1. India is rich with 633.92 Lakhs of MSME units and 4000 large scale enterprises. The contribution of MSME to the country's GDP was 28.77 % as of 2016 (Ministry of MSME, 2018).

Table 1: Classification of MSME, India (Source Ministry of MSME, 2006)

Enterprise	Investment in Lakhs of Rupees	
	Manufacturing (Investment in plant & Machinery)	Service (Investment in equipment)
Micro	<25	<10
Small	25-<500	10-<200
Medium	500-<1000	200-<500

SMEs are striving hard to market their products and/or services by competing in terms of quality and cost. Companies are forced to reduce the products' cost and increase the quality of the product to compete with the branded global products as well as their local competitors. This situation enforces the management to use quality improvement programs to increase the product quality without affecting their marginal profit in the shortest possible time (Basu 2001, George 2002, Herron and Hicks, 2008). Lean Six Sigma (LSS) is a proven methodology for the companies to use as a quality improvement program. LSS is a synergic combination of two proven quality improvement initiatives, namely Lean Manufacturing and Six Sigma. Lean manufacturing was pioneered by Toyota in the 1980s and is hence sometimes termed as Toyota Production System (TPS). TPS aims to increase the value of the product by reducing wastes. Six Sigma approach was developed by Motorola to reach near 'zero defect' through reducing variation in the processes (Hensley and Dobie, 2005). Both the approaches were successfully implemented in many large organisations and reaped the benefits. In the 2000s the combination of both approaches was conceptualised and later were tried by many organisations. At present, many large scale organisations are successfully running with LSS and reaps its' benefits (Kumar et al. 2006, Byrne et al. 2007, Schroeder et al. 2008).

The factors that can enhance the implementation of LSS in the firms are termed by researchers as Critical Success Factors (CSF). Researches have been conducted by many researchers in various countries concerning LSS implementation in SMEs (Graham et al. 2012). Various authors identified and termed the CSFs differently. Based on the literatures the CSF suggested by the researchers are: Management involvement and commitment; Cultural change; Communication; Organisation infrastructure; Training (Employee Involvement); Understanding its tools and techniques; Project management skills; The right selection of people and projects; time; money and other resources; Leadership; Supplier involvement (Nurul and Sha'ri, 2013, Graham et al. 2012, Arnheiter and Maleyeff, 2005, George 2002, Pojasek 2003).

METHODOLOGY

This study is aimed at identifying the critical success factors of the SMEs and comparing its' effect on performance on the various classification of industries. For studying this, the researchers conducted a questionnaire survey, and it's statistical analyses. The questionnaire was developed based on the literature review. The questionnaire contained 45 questions with a 5-point Likert scale ranging from 5 for strongly agree to 1 for strongly disagree. One hundred and seventy industries from Kerala and Karnataka states of India were considered in the research for sampling. The responses were collected through face to face interviews with managers or supervisors of the firms, which ensured a 100 % response rate. The SPSS 18 software is used for data analyses.

ANALYSES, RESULTS AND DISCUSSIONS

Cronbach's Alpha

The questionnaire was validated using a pilot survey at the initial stage of this research. After the data collection, the responses were inputted to the SPSS software for further analyses. The reliability had been tested using Cronbach's Alpha test. It has been reported that the value of 0.6 or above can be considered as an acceptable range (Sakakibara et al.2009). The result obtained is in table 1. In this research, the value of 0.902 was obtained for Cronbach's Alpha, which ensured that the data set has relatively high internal consistency and hence acceptable.

Table 1. Results of Cronbach's Alpha, KMO & Bartlett's Test

Item		Values
Valid Cases		170
Number of variables		45
Cronbach's Alpha		0.902
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.621
Bartlett's Test of Sphericity	Approximate Chi-Square	2212.815
	Degrees of Freedom	465
	Significance	0.000

Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's Test of Sphericity

The KMO statistic is a summary of how small the partial correlations are, relative to the original (zero-order) correlations. The partial correlation for each pair of variables in the factor analysis is comprised of the correlation between those variables after partializing out the influence of all of the other variables in the factor analysis. If the variables share common factor(s), then the partial correlations should be small, and the KMO should be close to 1.0. KMO value of 0.5 and above are considered as acceptable (Kim, J., & Mueller, L.W 1978). Here, the KMO value obtained is 0.621, which is satisfactory, and no deletion of items is necessary to make the value significant. The value of KMO obtained is provided in table 1.

The values obtained for the Bartlett's test is given in table 1. The test resulted in values of 2212.815 with a significance value of 0.000. The smaller value of significance level than 0.05, indicates that the data is suitable for Exploratory Factor Analysis (EFA).

Exploratory Factor Analysis

Next, EFA by using Principal Component analysis as the extraction method and Varimax with Kaiser Normalisation as the rotation is done. Table 2 represents the classification of variables to different factors based on the EFA output. The factors are termed according to the variables it contains.

Table 2: Factors Classified Based on Rotated Factor Matrix

FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6	FACTOR 7	FACTOR 8	FACTOR 9
Var-2	Var-1	Var-15	Var-5	Var-36	Var-11	Var-7	Var-31	Var-22
Var-4	Var-3	Var-17	Var-25	Var-37	Var-12	Var-8	Var-32	Var-23
Var-6	Var-28	Var-18	Var-42	Var-40	Var-13	Var-9	Var-33	Var-44
Var-16	Var-29	Var-19			Var-14	Var-10	Var-34	Var-45
Var-24	Var-30	Var-21			Var-20	Var-26		
Var-27								
Var-35								
Var-38								
Var-39								
Var-41								
Var-43								

Table 3 shows the variables loaded under each factor. The researcher analysed the variables grouped under each factor. Based on the nature of the variables grouped, terms were labelled to each group. It is understood that each of the factors identified contributes significantly to the industry for stepping into LSS implementation. The variables under each factor help to strengthen the score of particular factors. For example, variable 1 "Our managers Spend time on the plant floor to thoroughly understand the real-world manufacturing issues" measures the obligation of the industries' managers towards LSS implementation. This variable is loaded under top management commitment by EFA. It is sure that without top management initiatives and commitment no industry can achieve successful implementation of LSS, and thus a good measure for industry for this factor can be presumed to be benefitted in successful LSS implementation.

Table 3: Variables, Loading Factors and the CSF's Term Assigned

Question Number	Variable	Factor Loading	CSF's Term Assigned
2	Our company uses external experts/consultants on a regular basis to evaluate the overall company performance and to improve production and quality level.	0.869	Process and Productivity Improvement through waste reduction
4	Our company is capable of eliminating waste (muda).	0.621	
6	Our company is ready to invest for the continuous improvement and waste reduction efforts.	0.690	
16	The organization is willing to invest on plans that reduce wastage.	0.720	
24	Our equipment and procedures are designed in mistake proof manner.	0.685	
27	We always try to maintain the minimum level of inventory.	0.748	
35	The equipment's are kept clean and under proper loading conditions.	0.699	
38	Our organization has a strategy to identify the wastes.	0.771	
39	We have a framework to measure productivity loss comparing with a benchmark/baseline (tracking downtimes, slow cycles, rejection etc).	0.638	
41	Our company uses LSS tools.	0.964	
43	Company believes in doing things right first time itself.	0.584	
1	Our managers Spend time on the plant floor to thoroughly understand the real-world manufacturing issues.	0.562	Top Management Commitment
3	Our company invests in training programs and encourages cross-job training.	0.681	
28	We extensively use statistical techniques to reduce process variance	0.496	
29	We monitor and evaluate performance of equipment and processes periodically	0.538	
30	We maintain excellent records of all equipment maintenance related activities	0.603	
15	We give our suppliers feedback on quality and delivery performance	0.762	Organisation Culture and Infrastructure
17	Customer Feedback is sought regularly, and surveys/meetings are often held with customers to improve product design and quality and service	0.792	
18	There is a system in place for collecting customer complaints so that problems can be avoided in the future	0.821	

19	Customers participate in the initial design process	0.641	
21	Production is ''pulled'' by the shipment of finished goods	0.593	
5	Our company communicates the vision of the new initiative at every organizational level.	0.827	Communication
25	We try to improve the "value Added" process through step-by-step review and identification of connections, activities, information, and flow.	0.643	
42	Company gives a clear and precise communication when it launches a new initiative	0.587	
36	The organization has plans for expansion and improvement.	0.762	Financial Capabilities
37	Our company is capable of sustaining its initial efforts.	0.667	
40	Company uses latest technology wherever available.	0.583	
11	Suppliers are directly involved in the new product development process	0.687	Supplier Involvement
12	Our key suppliers are located in close proximity to our plants	0.468	
13	Our company maintains good relation with suppliers.	0.621	
14	We have a purchasing policy emphasizing quality rather than price	0.720	
20	Our key suppliers deliver to plant on JIT basis	0.648	
7	Employees are given authority and responsibility to carry out specific activities.	0.862	Employee Involvement
8	Workers are empowered to stop production line if abnormalities occur.	0.586	
9	Suggestions and ideas from shop-floor employees are actively used and implemented.	0.671	
10	Incentive programs and reward system are available for employees who lead product/process improvement efforts and eliminate necessary steps.	0.638	
26	Our employees practice setups to reduce the time required	0.798	
31	The organization provides adequate level of training to its employees.	0.976	Education and Training
32	The organization is flexible in incorporating new ideas.	0.624	
33	Our company conducts workshops or training to discuss scope for improvement.	0.567	
34	Our company monitors employees to find areas to improve their efficiency.	0.751	
22	Our company has satisfied & repeated customers.	0.831	Customer Satisfaction
23	We provide real time inventory information to our suppliers	0.642	
44	Our organization offers after sales service.	0.739	
45	The organization collects customer feedback.	0.642	

Comparison of the Effect of CSFS in Various Classification of Industries

Here, the industries responded to the study are classified based on three criteria such as ISO 9001 certified industries and non-ISO industries; Industries within industrial estates and industries outside industrial estates; Small sector industries and Medium sector industries. Independent sample t-test is used to compare the samples. The test compares the means of samples and checks for any difference in the result obtained. The hypotheses for the t-test were:

H0: No considerable difference for the factor between the types.

H1: Considerable difference is present for the factor.

Significance level: 95%

Rejects Ho if $p < 0.05$

Table 4: T-Test Results as a Comparison of Various Group.

Factor	ISO 9001 VS Non-ISO	Within Industrial Estate VS Outside	Small VS Medium
Process and Productivity Improvement	0.3125	0.2414	0.5614
Top management commitment	0.0022*	0.4115	0.0002*
Organization culture and infrastructure	0.5728	0.1375	0.2168
Communication	0.0932	0.4739	0.2404
Financial capabilities	0.5520	0.9047	0.0317*
Supplier involvement	0.5629	0.2593	0.1690
Employee involvement	0.3219	0.1777	0.4935
Education and training	0.2982	0.0247*	0.2404
Customer satisfaction	0.2894	0.1390	0.7013

*- Significance value less than 0.05.

Table 4 consolidates the significance value of t-test and table 5 provides the insight for numbers of each category participated in this research.

Table 5: The Numbers of Organisations Under Each Category for The Study

The numbers of organisations under each category, out of a total number of 170	
ISO Certified: 72	Non-ISO: 98
Inside industrial estate: 104	Outside industrial estate: 66
Small scale: 119	Medium scale: 51

Comparison Between ISO 9001 Certified Companies Vs Non-ISO Companies

From table 4, all the factors except top management commitment has a value more than 0.05. Hence the factors waste management, organisation culture and infrastructure, communication, financial capabilities supplier involvement, employee involvement, education and training and customer satisfaction have the same effect at both ISO and non-ISO organisations.

The change in top management commitment is obvious; that is why the ISO certified organisations went for certification even though ISO Certification is not compulsory in the market.

Comparison Between Organisations Within the Industrial Area and Outside Industrial Area

All the factors except Education and Training have significance value greater than 0.05, and thus can be inferred as having the same contribution by these success factors to both categories of industries.

By referring table 4, the difference observed in education and training may be because the government and industrial organisations generally set up common facility centre and training centres near industrial areas, which may help the employees to get more education and training. The industries located within the industrial area can share best practices relating to quality standards, quality practices etc. which would be beneficial to all the related industries. These possibilities may not be available for the industries situated outside the industrial areas and specifically those in the rural areas.

Comparison Between Small Scale Organisations and Medium Scale Organisations

The values of significance less than 0.05 for most of the factors which ensure the similarity of the conditions within both category of firms. The difference analysed were in Top management commitment and financial capability as given in the table 4.

Generally, the authors could presume that the medium sector has better financial stability than the small-scale sector. Generally, they have a better investment; better employee strength; are aimed at a greater number of customers; and may have more financial back up etc. This makes the medium sector more stable in terms of financial capability and in-turn drives them to adopt manufacturing management models.

Referring variation in the factor top management commitment, the authors feel that this happens due to any of the two reasons such as:

- The financial background of medium enterprises is stable compared to small enterprises. Thus, the medium enterprises can have more financial flexibility, and funding provision,it makes them to take more initiative towards quality improvement programs.
- The medium sector industries may have a greater number of managers for monitoring and controlling operations. Hence the top management can more concentrate on planning strategies for the company's progression.

CONCLUSIONS

Current situation forces the industries to produce quality products with lower costs. This makes many of the Indian SMEs take quality initiatives. LSS is a proven methodology that helps companies to improve the quality and to reduce production costs. Many of the Indian SMEs tried to implement LSS and could achieve successful running inthe initial stages. But only a few companies achieved a sustainable implementation of these methodologies. For the successful implementation of these methodologies, the success factors must be available in the company. Hence this study tries to identify the critical success factors for LSS implementation at SMEs. The CSFs were identified by using EFA, and suitable terms were given according to the nature of variables within. Later comparison studies using paired t-test were done to check the effect of these factors between various classifications of SMEs.

This paper is the foundation part of the research work conducted by the authors. Ramkumar et al. (2019) report another study regarding identification and ranking of seven wastes (Muda), which together led to model development for LSS implementation. The researchers developed a model termed Identify-Rank-Define-Analyse-Improve-Control (IRDAIC) that helps SMEs to implement LSS and thus reap its benefits. The model is aimed at identifying and reducing the wastes and thus improving the process and productivity. The researchers validated the model by conducting case studies at the industries which implemented the IRDAIC model.

The samples were only taken from two states of India, and hence be generalised. Hence the study may be extended to different locations at different states. Similarly, the present study was aimed mainly at manufacturing organisations, which may be extended to the service sector too to confirm the effect the factors have is the same.

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